Johnson Space Center

Task

Development of In-situ Nondestructive Evaluation Techniques and Physical Standards for Inspection of Welded Tubing used in Spacecraft

Center Point of Contact

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Objective

Develop and validate an eddy current inspection technique for orbital tubing welds that cannot be inspected using the normally applied methods due to access restrictions.

Background

Orbital welding processes are widely used in the manufacture of pressurized tubing assemblies found in spacecraft environmental control and propulsion systems. The structural integrity of tubing assemblies is ensured through proof testing, leak testing and pre and post proof nondestructive inspection of the orbital welds. Weld inspections typically consist of visual, dye penetrant and radiographic inspections designed to detect a variety of anomalies such as porosity, cracks, incomplete penetration and incomplete fusion.

In many instances the complexity of the tubing assembly restricts access to the orbital welds making full inspection problematic, especially in the case of radiography. In these situations, the inspection requirements are often modified to permit partial inspection or to eliminate one or more inspection methods in their entirety. As a result, confidence in the integrity of the inaccessible weld and by extension the entire tubing assembly is reduced. Therefore, an alternative inspection technique is needed that can substitute for the traditional dye penetrant and radiographic inspections in cases where access to the weld is limited. Recognizing that the inaccessible weld locations must be accessible for welding, this project aims to develop and validate an eddy current inspection scanning device based on a commercially available orbital tube welding head. Tubing samples containing electrical discharge machining (EDM) notches, fatigue cracks and natural weld defects will be produced to assess and down select eddy current probe and scanner options as well as conduct a probability of detection (POD) assessment of the final inspection device.

Benefits/Payoffs

The in-situ eddy current technique developed by this project will increase safety and mission assurance by making it possible to inspect previously uninspectable welds for flaws which could potentially lead to the failure of pressurized systems. The inspection technique will benefit programs with tubing assemblies containing welds with limited access such as the Orion Multipurpose Crew Vehicle.

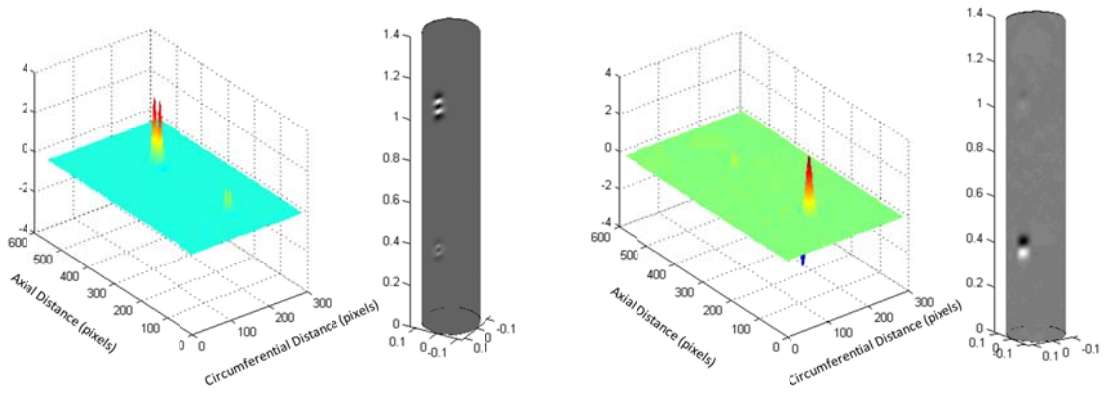
Recent Accomplishments

Commercially available and custom wound eddy current probes have been successfully tested on tubing samples containing outer and inner diameter EDM notches (Figure 1). Manufacture of a prototype Orbital Eddy Current Inspection System is complete (Figure 2). The prototype, based on a modified Weldlogic Inc. Model STW-100 Micro-Flex

orbital welding head, enables eddy current inspection on installed tubing over a 360 degree x 0.5 inch surface area.

Current Activities

Software is being devised to control scanning and data acquisition sequence for in-situ NDE of welded tubing. In addition, bending fatigue cracking procedures for tubing samples are being developed.



a. b.

Figure 1: Eddy Current Responses from O.D. EDM Notches in a 316 Stainless Steel Tube Standard (a. Uniwest 1MHz Probe; b. Custom Wound 1 MHz Probe)

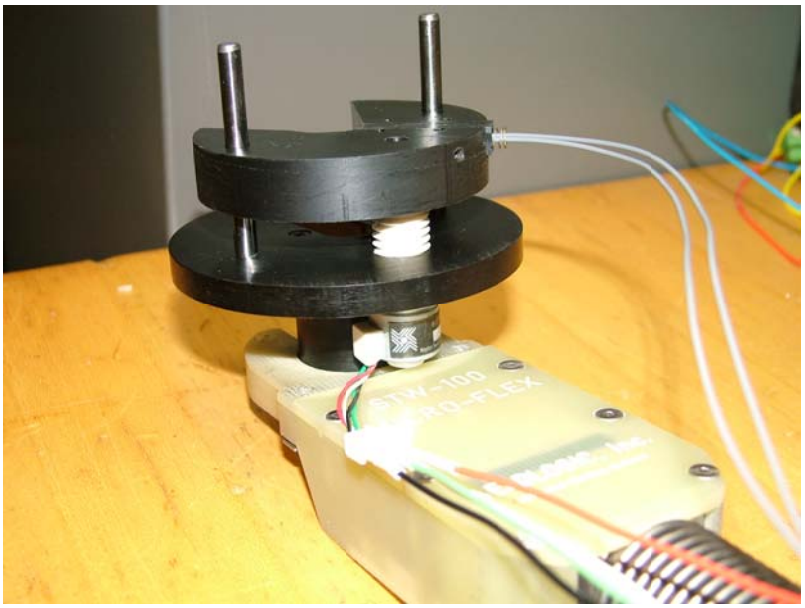


Figure 2: Prototype Orbital Eddy Current Inspection System